THE WHEAT JOINTWORM AND ITS CONTROL

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THE wheat jointworm ranks next to the hessian fly as a wheat pest in the majority of the wheat States east of the Mississippi River and in parts of Missouri, Utah, and Oregon. Little is done to control it; in fact, certain farming practices of crop rotation afford it ideal breeding conditions.

This jointworm can be controlled by plowing wheat stubble under deeply, after harvest, wherever this is practicable and does not interfere with the growing of red clover and grasses. Rye may be substituted with safety for wheat in the more northerly States where jointworm injury is severe, because it is not subject to attack by this jointworm. Rye is a good bread grain, cover crop, green manure, and nurse crop for clover.

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THE WHEAT JOINTWORM AND ITS CONTROL

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IMPORTANCE OF THE WHEAT JOINTWORM

THE WHEAT JOINTWORM (*Harmolita tritici* (Fitch)) is a very small grub which lives in the stems of wheat, feeding on the juices of the plant and usually causing a slight swelling or distortion

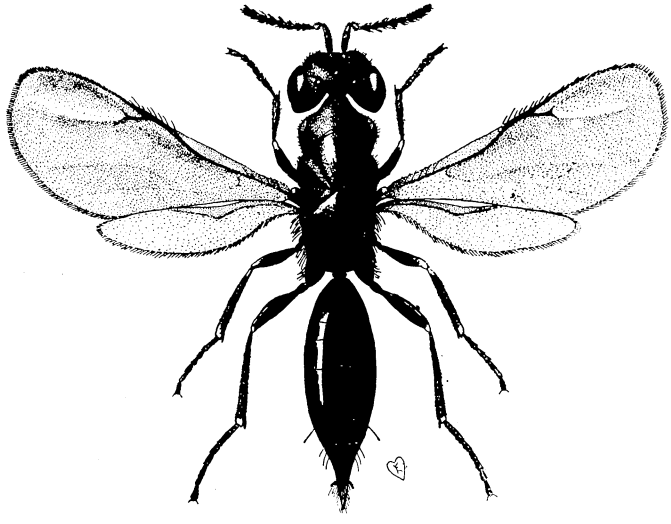

FIGURE 1.—Adult female of the wheat jointworm. Enlarged about 16 times. (The head is tilted back somewhat so as to show the groove in front.)

of the stem above the joint. The egg from which it hatches is laid in the stem by an insect resembling a small black ant with wings (fig. 1). This insect attacks wheat only. The injury (fig. 2) which

[1] Retired Dec. 31, 1934.

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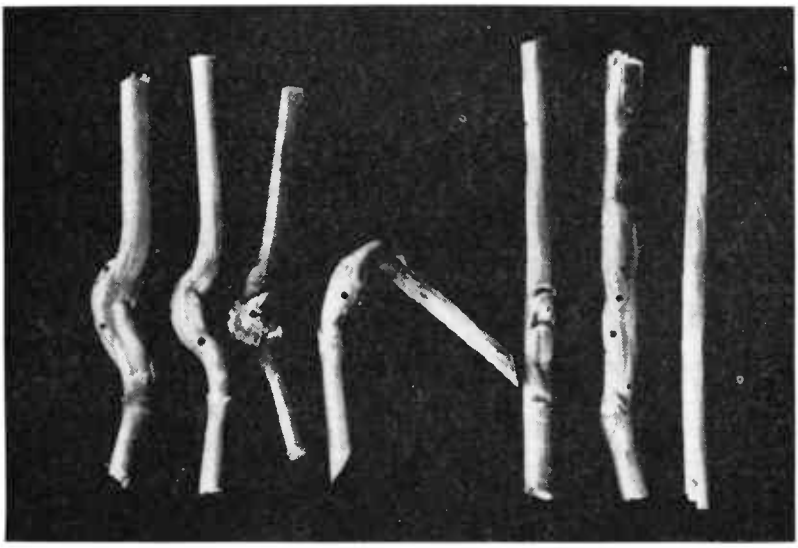

FIGURE 2.—Sections of wheat stems, showing typical galls or injury from the wheat jointworm. About natural size.

it causes to wheat is very distinct from that caused by the hessian fly (fig. 3), yet the effects caused by these two insects are often confused by farmers.

FIGURE 3.—Hessian fly "flaxseeds" on wheat straws from stubblefield. About natural size. (After Rockwood. Oreg. Agr. Expt. Sta. Cir. 77.)

In destructiveness to wheat the jointworm ranks next to the hessian fly within the States involved, the damage running into millions of bushels in some years. At times in some areas the jointworm is more injurious than the hessian fly, chiefly because the measures available for its control are much less generally applied. In fact some of the widely used crop rotations furnish ideal conditions for jointworm development.

HISTORY AND DISTRIBUTION OF THE WHEAT JOINTWORM IN THE UNITED STATES

The wheat jointworm is a very old enemy of wheat. The first record of its occurrence in the United States was in 1821, when it was observed in Bucks County, Pa. The earliest outbreak on record was in 1848, in the vicinity of Charlottesville, Albemarle County,

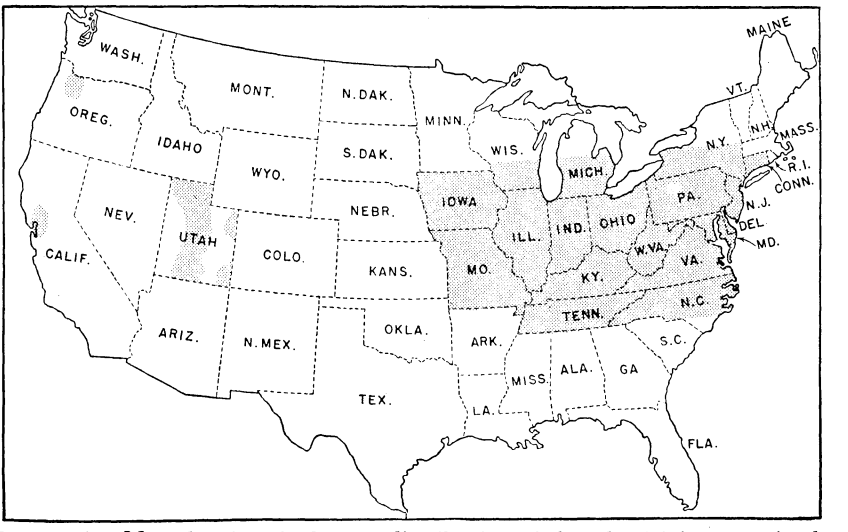

FIGURE 4.—Map showing the known distribution of the wheat jointworm in the United States in 1940.

and Gordonsville, Orange County, Va. In 1851 the wheat of Albemarle County was scarcely worth harvesting. In 1854 the outbreak had assumed such alarming proportions that a "jointworm convention" was called at Warrenton, Fauquier County, Va., to consider the best means of controlling this pest.

By the early eighties this insect had become widely dispersed, causing considerable injury to wheat in Virginia, Ohio, Michigan, and New York. Again in the nineties it claimed serious attention, and during the period from 1909 to 1939 the jointworm caused serious loss in practically all the main wheat-growing States east of the Mississippi River, and in some years it caused serious loss in Missouri. In 1914 it was reported in Utah and in 1918 in California, where it is present in Yolo and Solano Counties. In 1926 it was found in the Willamette Valley, in western Oregon.

For reasons as yet not clearly understood, but probably climatic, it is not known to be established in Kansas and certain other important midwestern wheat-growing States. The distribution of the wheat jointworm, as known in 1940, is shown in figure 4.

NATURE OF INJURY

This jointworm attacks wheat only, and this habit greatly simplifies control measures. When a wheat plant has become infested, no outward sign necessarily appears. The presence of the jointworm

FIGURE 5.—Opened wheat jointworm cells showing the mature larvae. About natural size.

may best be detected when the plant is nearly mature, by pinching the stem between the forefinger and the thumb. Infested plants will be found to contain a hard, woody place (called a gall) in the stem, usually just above the second or the third joint from the ground.

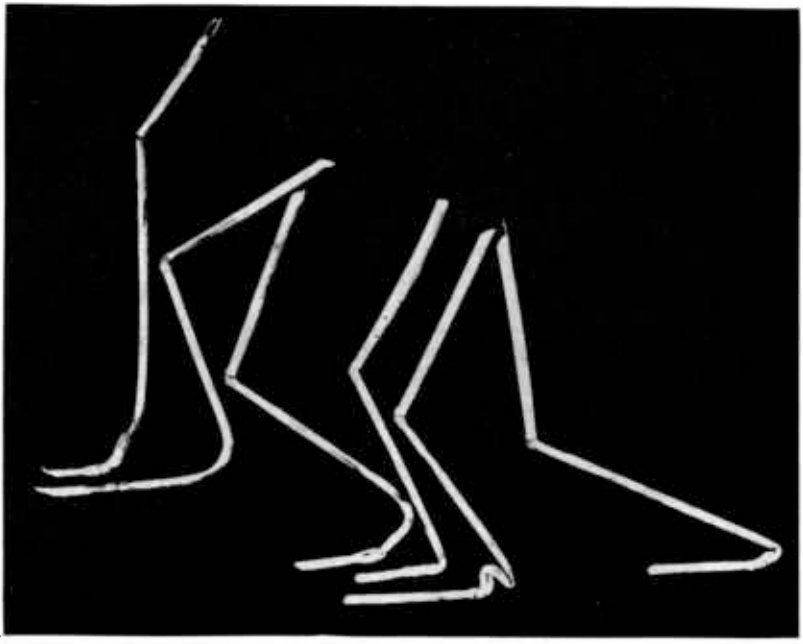

FIGURE 6.—Typical fallen straws infested by the wheat jointworm, showing the angle at which they bend over. About one-third natural size.

When these hard places are chipped open with a sharp knife, larvae or grubs will be found inside the stem in distinct little cells or cavities (fig. 5).

Very often the point of infestation is very noticeable, there being wartlike swellings (fig. 2) on the stem. Another good indication is

FIGURE 7.—A badly infested wheatfield in which many of the stems have fallen down. Injury caused by the wheat jointworm.

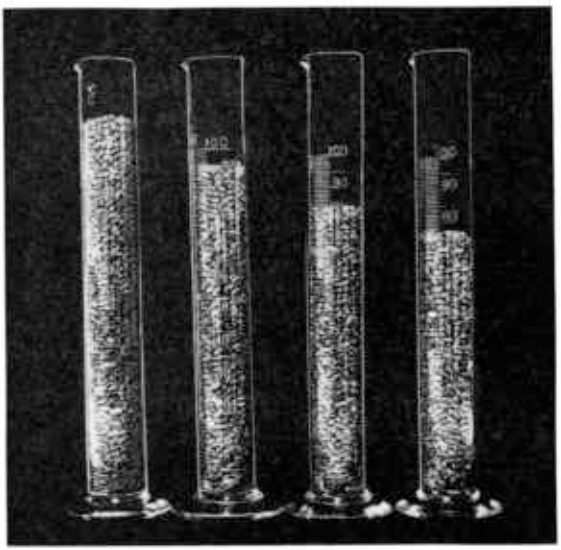

FIGURE 8.—Comparative yields (left to right) of 85 heads each from healthy stems, from stems infested by the wheat jointworm at one internode, from stems infested at two internodes, and from fallen straws, respectively. Though all these heads were of the same length, the difference in yield is marked.

the presence in the field of a number of fallen or lodged straws. This can be readily observed from a distance, and the condition is often attributed by farmers to the work of the hessian fly. A close examination of these fallen straws, however, will show hard, woody galls at or near the point where the stem bends over (fig. 6). When a stem breaks over from hessian fly attack, no such woody, hard place in the straw is present, and at, or just below, the bend or break there

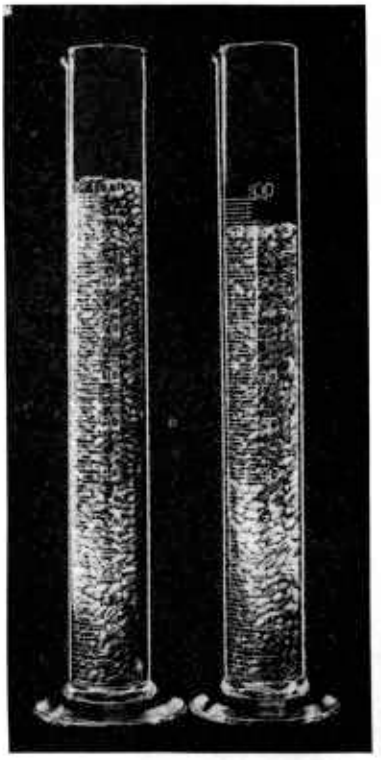

FIGURE 9.—Yield from strong, vigorous wheat; from 85 healthy stems (at left) and from 85 jointworm-infested stems (at right). Note the relatively greater damage done to poor wheat as shown in figure 10.

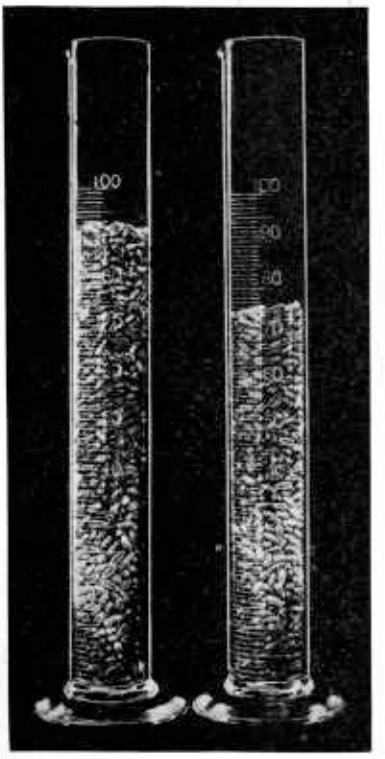

FIGURE 10.—Yield from poor, weak-growing wheat; from 85 healthy stems (at left) and from 85 jointworm-infested stems (at right). Note the relatively greater injury to this poor wheat than to strong, vigorous wheat as shown in figure 9.

will be found either greenish-white, footless grubs or brown, flaxseed-like objects between the leaf sheath and the main stem (fig. 3).

The damage done to the wheat in a field by the jointworm may vary from slight injury to total destruction. In the latter case practically all the stems fall. The title-page illustration and figure 7 show close and distant views, respectively, of such badly lodged wheat.

In harvesting, the heads on the fallen stems are often too near the surface of the ground to be saved and are therefore lost. Often when badly lodged wheat is cut by the binder many of the fallen stems are

cut just below the head, and such heads are lost because they either are not bound in the bundles or, should they be bound, the necessary handling later will cause them to be lost before threshing is completed.

It is not necessary, however, for large numbers of the stems to lodge or fall to reduce the yield greatly, especially if a high proportion of the stems are infested by this insect. The hardened, knotty places in the stems apparently interfere with the normal development and proper nourishment of the kernels, leaving them not only lighter in weight but also considerably smaller in size.

Figure 8 shows the actual yield of grain from 85 heads taken from healthy stems in comparison with that from the same number of heads of equal length from stems infested at one joint, from stems infested at two joints, and from 85 heads of equal length from infested stems that had lodged or fallen. Strong, vigorous wheat is not injured as severely as poorer wheat, and this is shown by the yield from 85 heads from infested and uninfested stems of good and poor wheat (figs. 9 and 10). In this comparison the heads of the poor wheat were not equal in length to the heads of the good wheat, and only heads of average length in each lot were taken to show these comparative differences in yield. In both lots the heads of infested stems were carefully matched against the heads of uninfested stems from the same lot, and the grain was painstakingly threshed by hand so that no kernels were lost. The difference in weight is fully as great as the difference in bulk. This is conclusive proof that even where the stems do not fall or lodge, much injury is done where the proportion of infested stems is large.

SEASONAL HISTORY

Like many other insects, the jointworm has four stages in its life history, namely, the egg; the larva, or wormlike grub; the pupa, or

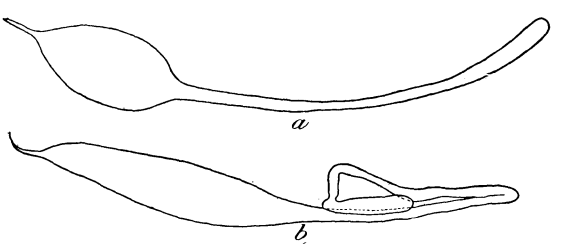

FIGURE 11.—Shape of wheat jointworm eggs: *a*, Before oviposition; *b*, after the egg has been pushed down into the plant tissue.

resting stage; and the adult, or parent insect. This insect completes its entire life cycle only once each year.

THE EGG

The eggs are very small and white and are shaped as shown in figure 11. The adult, with her sharp, needlelike ovipositor, inserts them in the wheat stem just above the joint. As many as 18 eggs have been found at one joint. Egg laying (fig. 12) occurs during April or May, shortly after the emergence of the adults which develop

from the pupae or larvae that have overwintered in the wheat straw and stubble of the previous season. The eggs are laid only during the day, and one female may deposit as many as 70 or more. The eggs hatch in about 12 days, more or less, depending upon the temperature.

FIGURE 12.—Wheat jointworm adult pushing an egg down into a plant stem. About 3 times natural size.

THE LARVA, OR WORM

The larva at the time of hatching is very small, whitish, and translucent. It soon forms a small cell in the wall of the stem, from which it never departs. It is footless, and its mouth is provided with a pair of tiny hooks or mandibles with which it rasps the tissues of the plant to obtain the plant sap for food. The presence and feeding of the larvae cause a distinct disturbance in the stem tissue surrounding them, resulting in the formation of swellings or galls just above the joints, the weakening of the stems immediately above the galls, and the breaking over or lodging of the wheat by wind or rain as the heads become heavier with grain. The larvae reach maturity and finish feeding just before the wheat ripens. By this time they are yellowish and about one-fourth of an inch long (fig. 13). When several cells are located near one another the stem at that point becomes galled, very hard, and woody. On an average there are about eight cells, each containing one larva, in a single gall.

When the wheat is cut, a large majority of the larvae usually remain undisturbed in the stubble because most of the galls are located near the lowest joints of the stems. In most of the areas where this insect occurs clover or grass is usually sown in the wheat. For this reason the old stubble is left standing for nearly a year, thus furnishing ideal conditions for this pest to complete its development.

THE PUPA, OR RESTING STAGE

By November or December about 90 percent of the larvae in the stubble have changed to pupae within the cells. The pupa (fig. 14) is about three-sixteenths of an inch in length and at first is pale yellow, gradually turning darker until spring, when it becomes black. During the pupal stage, which is transitional between the mature larva and the adult, no feeding occurs. In April or May the adults emerge. Each one gnaws a small circular hole in the outer wall of its cell, crawls out, and flies away in search of growing wheat.

THE ADULT, OR PARENT

The adult insect (fig. 1) usually escapes observation, as it is very small and is present in the fields only about a month during the year. It is about three-sixteenths of an inch long, is black, has four delicate, transparent wings, and resembles a winged ant. The adult does no noticeable damage to the wheat. When it emerges from the stubble, it searches for growing wheat, and, although not a strong flier, it may be carried for considerable distances by the wind, which is apparently the chief agency in dissemination. For this reason a space of several

FIGURE 13.—Full-grown larva, or grub, of the wheat jointworm. About 10 times natural size.

FIGURE 14.—Pupa, or resting stage, of the wheat jointworm. About 11 times natural size. This is the stage in which most of the jointworms pass the winter in the stubble.

hundred yards between an old stubble field and growing wheat may be of little value as protection against the jointworm when it is very abundant.

NATURAL CONTROL

Large numbers of pupae and larvae of the jointworm are killed during some winters. This is especially true when the galls in which they overwinter are exposed to unusually wet conditions during periods of low temperature. Such weather conditions apparently are less harmful to certain species of parasites which attack the jointworm than they are to the jointworm itself. Without the assistance of the parasitic enemies of the jointworm, farmers in areas badly infested by this insect probably would find wheat growing unprofitable unless they adopted artificial measures of control.

Each of the several kinds of parasites varies in effectiveness from year to year and from locality to locality, depending upon the influence of many factors. Three of the species which deserve special

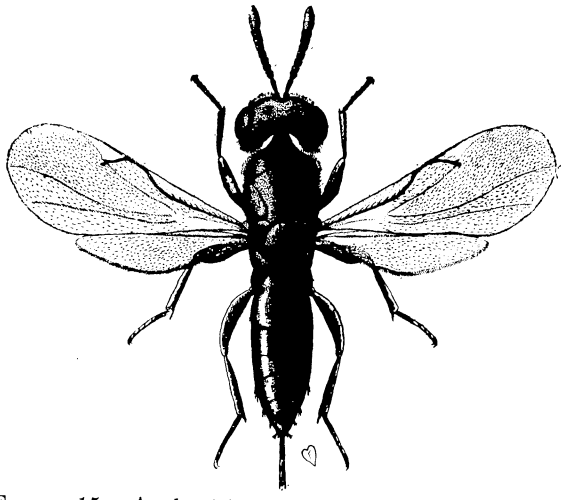

FIGURE 15.—A wheat jointworm parasite, *Ditropinotus aureoviridis*. Enlarged about 16 diameters.

notice are briefly discussed here. All are minute four-winged wasps in the adult or parent stage, and about the same size as the adult of the jointworm.

One species, *Ditropinotus aureoviridis* Crawford, in which the female (fig. 15) is dark brownish and the male a golden green, has two complete generations and a partial third each year in central Virginia. The eggs are deposited in the cells occupied by the jointworm, and when the young parasite grub hatches from the egg it begins to devour the jointworm. The last generation of this parasite passes the winter as larvae or grubs in the cells of the hardened pieces of straw of the old wheat stubble and emerges in the spring after the jointworm larvae are well developed in the new wheat.

A second species of parasite, *Eupelmus allynii* (French) (fig. 16), in the adult stage is iridescent, greenish black or purplish black, with yellowish legs. Its life history is approximately the same as that of the species just described, with the exception that four or more generations a year have been observed.

The third species, *Eurytoma parva* Phillips (fig. 17), is black, and it is not easily distinguished from the adult of the jointworm. It differs considerably in life history from the other parasites. Its eggs are deposited about the time the

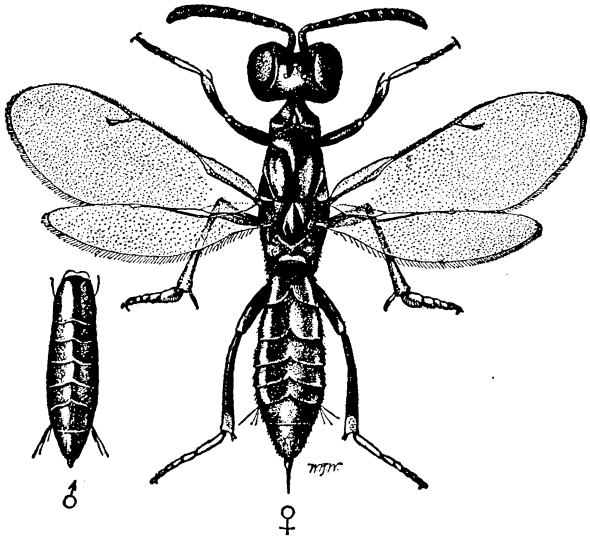

FIGURE 16.—A wheat jointworm parasite, *Eupelmus allynii*. Enlarged about 20 diameters.

jointworm is one-fifth grown. The newly hatched larva devours the jointworm and completes its development on the plant tissues. While the insect actually lives for a part of its life at the expense of the wheat plant, it is entirely dependent upon the jointworm for starting its development and is therefore a truly beneficial species. It has a single generation each year and passes the winter in the larval, or grub, stage in the stubble.

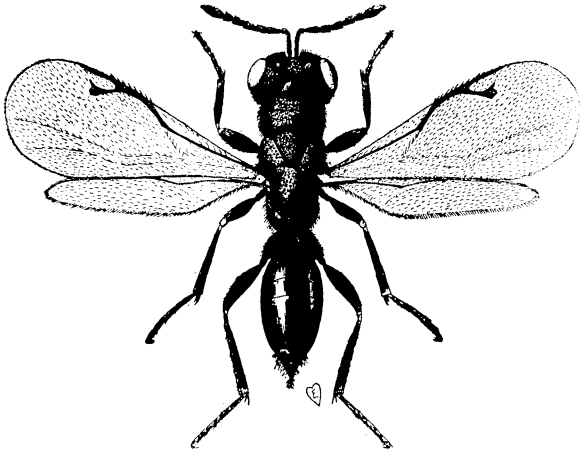

FIGURE 17.—A wheat jointworm parasite, *Eurytoma parva*. Enlarged about 15 diameters.

A number of other parasitic and predacious enemies of the jointworm play important parts in the control. *However, the combined effect of all its natural enemies frequently is not sufficient to prevent serious jointworm injury to the crop. When outbreaks of this insect occur, therefore, wheat growers should practice consistently the remedies recommended in this bulletin.*

CONTROL MEASURES

As previously stated, little is done, generally speaking, to control the jointworm. The prevailing methods of farming in most of the regions infested by it are favorable to the increase rather than the repression of this insect, which for the most part lives over winter within the wheat stubble. In order to render effective the control methods recommended herein, wheat growers throughout heavily infested areas should unite in a thorough control program.

CONTROL BY CULTURAL METHODS

In localities where the wheat has been seriously damaged by the jointworm it may be controlled effectively by plowing the stubble under deeply enough, preferably late in the summer or early in the fall, to prevent the emergence of the adults during the following spring. Objections to this recommendation, because of its interference with the growing of red clover and other crops that were formerly considered indispensable in soil conservation, may be met by the temporary substitution of soybeans, sweetclover, and other crops for forage and green manure. Where the foregoing method is adopted, all badly infested wheat should be cut as high as practicable so that most of the jointworms will be left in the standing stubble (see figs. 2 and 5) and may then be plowed under and destroyed.

In Southern and Southeastern States, where double-cropping systems are in general use, and in Western States, where summer fallowing is recommended, it should be possible to plow the stubble under throughout large areas and thus secure effective control of the jointworm. In regions where red clover culture is considered indispensable or where this method conflicts with accepted soil-conservation practices, it should not be adopted and might be employed only in cases where unusually severe infestations threaten very heavy losses to the wheat crop.

It is advisable to sow wheat as far as practicable from any unplowed wheat stubble of the previous year. This practice aids in preventing the jointworm adults that emerge from stubble of the previous year's wheat crop from finding the new crop of growing wheat in which to deposit their eggs.

A common practice during the winter and early in the spring in many wheat-growing areas is to top-dress the land sown in wheat with manure containing straw that has been used for bedding but is not well rotted or thoroughly trampled. When the jointworm is very abundant such straw has been found to contain living jointworms in numbers sufficient to reinfest the growing wheat to a considerable extent upon the emergence of the adults. Therefore, in areas where severe losses from the jointworm have occurred during the preceding season, land sown to wheat should be top-dressed only with manure containing straw that has been well rotted or thoroughly trampled.

SUBSTITUTION OF CROPS IMMUNE TO JOINTWORM INJURY

The wheat jointworm does not attack any plant other than wheat. Therefore it is possible to substitute rye, barley, oats, or buckwheat for wheat with entire safety in localities where the jointworm is causing severe damage. Of the four crops mentioned, rye doubtless is the most suitable substitute for wheat in most of the winter wheat areas. It may be grown in almost any region where winter wheat will grow, is a satisfactory nurse crop for clover, and can be grown successfully on poorer and sandier soils than wheat and with less fertilizer. This last is important, because the jointworm injury is more severe in poor wheat than in strongly growing stands.

Rye is a good cover, green-manure, and grazing crop and can be grown more safely in some of the Northern States than winter wheat. This is particularly true of Michigan and Wisconsin, where jointworm injury is sometimes severe. Rye is not often severely injured by the hessian fly or other important insect enemies of wheat. It is also a good bread grain and is largely used by many people of this and other countries. The substitution of rye or other small grains for wheat is not recommended as a remedy for jointworm injury except where losses from this cause are serious and where it becomes necessary to adopt vigorous control measures.

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